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NAVWEPS REPORT 7374

DEVELOPMENT OF THE EX 25 MOD 0 CONTINUOUS ROD WARHEAD FOR THE SPARROW I AIR-TO-AIR MISSILE (C)

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12 JANUARY 1961

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U. S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

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Prepared by:

P. W. Naylor

ABSTRACT: A continuous rod warhead has been developed for the SPARROW I air-to-air missile. This warhead satisfies all strength and environmental requirements for the SPARROW I missile. Continuity of cut averaged 87% at 21-foot radius and the average rod velocity over 21 feet was 3500 ft/sec. The SPARROW I missile was superseded by the SPARROW III and all development work on the SPARROW I terminated prior to release of the warhead to Prototype Production for Evaluation (PPE). However, had the program not been terminated, it is believed that the warhead would have met all PPE release criteria.

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This development was performed by the Government Products Division of the Rheem Manufacturing Company (now a Division of Aerojet General) for the Bureau of Ordnance (ReW), under the technical direction of the Naval Ordnance Laboratory, White Oak. The purpose of this task was to develop a continuous rod warhead for the SPARROW I air-to-air missile. Work on this warhead was terminated when the SPARROW I missile was replaced by the SPARROW III missile.

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W. D. COLEMAN
Captain, USN
Commander

J. H. Armstrong
J. H. Armstrong
By direction

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REFERENCES

(a) Contract NOrd 17482; Development of Guided Missile Warhead EX 25 Mod 0

(b) Rheem Manufacturing Company, Downey, California; Summary Report R-263-9 and monthly reports R-263-1 through R-263-8, Design, Development, and Fabrication of Warhead, EX 25 Mod 0, For SPARROW I (Contract NOrd 17482)

(c) Sperry Gyroscope Company ltr.4212.81C.W1 of 15 May 1957 to NOL(WO)

(d) Chamberlain Corporation, Waterloo, Iowa; Report of Static Firing Test of Six Modified EX 25 Warheads (Contract N60921-4735)

(e) Chamberlain Corporation, Waterloo, Iowa; Report of Manufacture and Static Firing Test of Experimental Warheads Items I and II (Contract N60921-5206)

DEVELOPMENT OF THE EX 25 MOD 0 CONTINUOUS ROD WARHEAD FOR THE SPARROW I AIR-TO-AIR MISSILE (C)

INTRODUCTION

1. This report is prepared to summarize and document the development and prototype production of the EX 25 Mod 0 continuous rod warhead for the SPARROW I air-to-air guided missile. The warhead was developed and fabricated on a research and development contract (reference (a)) by the Government Products Division of the Rheem Manufacturing Company (now a division of the Aerojet General Corporation), Downey, California, with technical direction by NOL(WO). Terms of the contract called for design and development of a warhead to meet certain performance, environmental, strength, and configurational requirements; fabrication of forty prototype warheads; and preparation of detail drawings. Details of the Rheem development program, including results of performance, strength, and environmental tests, are documented in reference (b).

The SPARROW I missile was superseded by the SPARROW III missile and all SPARROW I warhead development was terminated in June 1957 before the EX 25 Mod 0 warhead could be evaluated. However, based on all tests performed at Rheem, the EX 25 Mod 0 warhead was considered to have met all criteria for release to PPE.

WARHEAD DIMENSIONS AND MECHANICAL SPECIFICATIONS

2. For mutual improvement of the combined fuze-warhead design, an allowable warhead weight increase over the then-current warhead specification was obtained through coordination with the Naval Ordnance Laboratory, Corona, which was responsible for fuze development; and the prime SPARROW I contractor, Sperry Gyroscope Company. This weight increase permitted maximum utilization of the warhead configuration with the largest possible rod bundle. To facilitate manufacture, Sperry Gyroscope Company agreed to use of a conical fairing in lieu of the ogival fairing used on the SPARROW I fragmenting warhead. All other dimensions, threads, etc., were compatible with other components of the SPARROW I missile. Principal warhead dimensions are shown in Table I and enclosure (1).

TABLE I

Principal Dimensions EX 25 Mod 0 Warhead

Length; overall	14.992 in.
Length; skin break to skin break	14.250 in.
Outside diameter; aft. skin break	7.596 in.
Outside diameter; fwd. skin break	6.072 in.
Inside diameter; central tube	1.750 in.
Explosive weight (approx.)	9.25 lb
Weight	47.7±1.0 lb
CG; from aft. skin break (ref.)	7.480 in.
Moment; about missile glide CG (sta. 73.78)	1861±48 in-lb

3. The rod bundle of the EX 25 Mod 0 warhead was fabricated from 1008 steel, 3/16-inch square rods with rounded corners. Hinge and stitch welds were made by fusing the rod ends together without the use of filler material. The strength of this joint was equal to other hinge welds and the method was superior, cost-and time-wise. The cut-off tubes were 3/8-inch diameter. All structural loads were carried by the fairing, tension skin, and end plates with the rod bundle providing structural stiffness only. Since the rod bundle was not a main structural member, it was pressed into the body, rather than being welded to the end plates. This feature made it possible to change rod bundle design without affecting the warhead structural strength. The EX 25 Mod 0 warhead was subjected to the strength and environmental tests of Table II without detrimental effect.

TABLE II

Strength and Environmental Tests
(For complete details, see reference (b))

1. Tensile - 10,000 lb along the longitudinal axis (empty warhead)

2. Bending - 17,500 in-lb at aft end and 4,500 in-lb at fwd end (empty warhead)

3. Shear - 10,000 lb at aft end and 4,200 lb at fwd end (empty warhead)

4. Torsion - 10,000 in-lb about longitudinal axis (empty warhead)

5. Shock - 35g's set-back load for two seconds along the longitudinal axis (inert loaded warhead)

6. Vibration - (inert loaded warhead)

   a. 5 hrs @ 1100-3000 CPM; continuously varying frequency; .030-inch single amplitude; lateral and longitudinal directions

   b. Frequency sweep from 10-500 CPS in 10 minutes @6g single amplitude in lateral and longitudinal directions

   c. Vibrating the three most severe resonant frequencies of (b) for 5 minutes @6g

7. Drop Test - Forty feet on a 3-inch-thick steel plate (explosive loaded warhead)

8. Salt Spray - Fifty hours in accordance with Mil Spec MIL-T-5422c (ASG)

4. A set of Rheem drawings of the EX 25 Mod 0 Warhead was forwarded to Sperry Gyroscope Company for comment and approval. By reference (c), Sperry concurred that the design was compatible with the SPARROW I missile. The design has been reviewed by the Production Department of the Rheem Aircraft Division and found perfectly satisfactory for large-scale production with no changes required.

PERFORMANCE

5. The explosive loading of the EX 25 Mod 0 Warhead was 9-¼ pounds of composition H-6 explosive. For developmental tests, a dummy EX 12 Mod 0 safety and arming device with an eccentric booster located as shown on enclosure (1) was used to initiate the warhead. This eccentricity was caused by the requirement for a cable assembly (connecting the fuze and guidance section) which passed through the central tube of the warhead. The continuity of cut averaged 87% at 21-foot radius and the average rod velocity over 21 feet was 3500 ft/sec. In all tests there was rod breakup in the direction of booster eccentricity and also, to a lesser degree, diametrically opposite. If the two sections in the plane of booster eccentricity are ignored, the continuity of cut averaged 94%. It is believed that the continuity of cut obtained was the maximum possible with this warhead and booster location.

COMMENT ON RHEEM DEVELOPMENT EFFORT

6. It is considered that the effort and initiative expended by Rheem on this contract was excellent. Elimination of filler material in the rod hinge welds and introduction of the separate non-integral rod bundle reduced fabrication costs considerably and also added valuable basic "state-of-the-art" knowledge to the field of continuous rod warhead design. Rheem also proposed several additional changes, including elimination of cut-off tubes and use of a folded one-piece rod bundle. The scope of the contract did not permit investigation of these features. However, some EX 25 Mod 0 Warheads were later modified to eliminate cut-off tubes. These and a similar type folded rod bundle were tested by the Chamberlain Corporation with favorable results as reported in references (a) and (e).

7. Rheem devised an automatic welding jig to do the hinge and stitch welds. This jig was quite promising but the contract was completed before the jig was completely operational and reliable. Rheem continued development of this jig for use on a subsequent production contract for fabrication of SPARROW III warheads. The jig was a major improvement in rod bundle fabrication, effecting savings in time and money.

8. An excellent photographic technique was developed by Rheem for obtaining a record of the rod bundle in flight. By use of a small lens opening and resulting small light admission, it was possible to observe the rod bundle silhouetted against the fireball and therefore determine the rod bundle condition and point of breakup along its trajectory.

SUMMARY

9. The EX 25 Mod 0 warheads were inspected at NOL(WO), and found to be within dimensions and specifications. The development phase was completed but the SPARROW I program was terminated in June 1957 prior to PPE release. No evaluation was made at NOL(WO) but based on the tests performed at Rheem, the warhead is considered to be acceptable for release to PPE. An assembly drawing of the EX 25 Mod 0 warhead is given in enclosure (2). A complete set of reproducibles of the Rheem drawings is on file at NOL(WO).

10. Should further effort be expended on this warhead, it is believed that improvement may be obtained by slight modifications such as:

a. A concentric booster to improve continuity of cut even if a larger central tube with corresponding reduction of high explosive is required

b. A plastic liner to replace the present magnesium liner if a suitable plastic can be obtained

c. Elimination of cut-off tubes

d. A folded one-piece rod bundle (eliminating hinge welds and cut-off tubes)

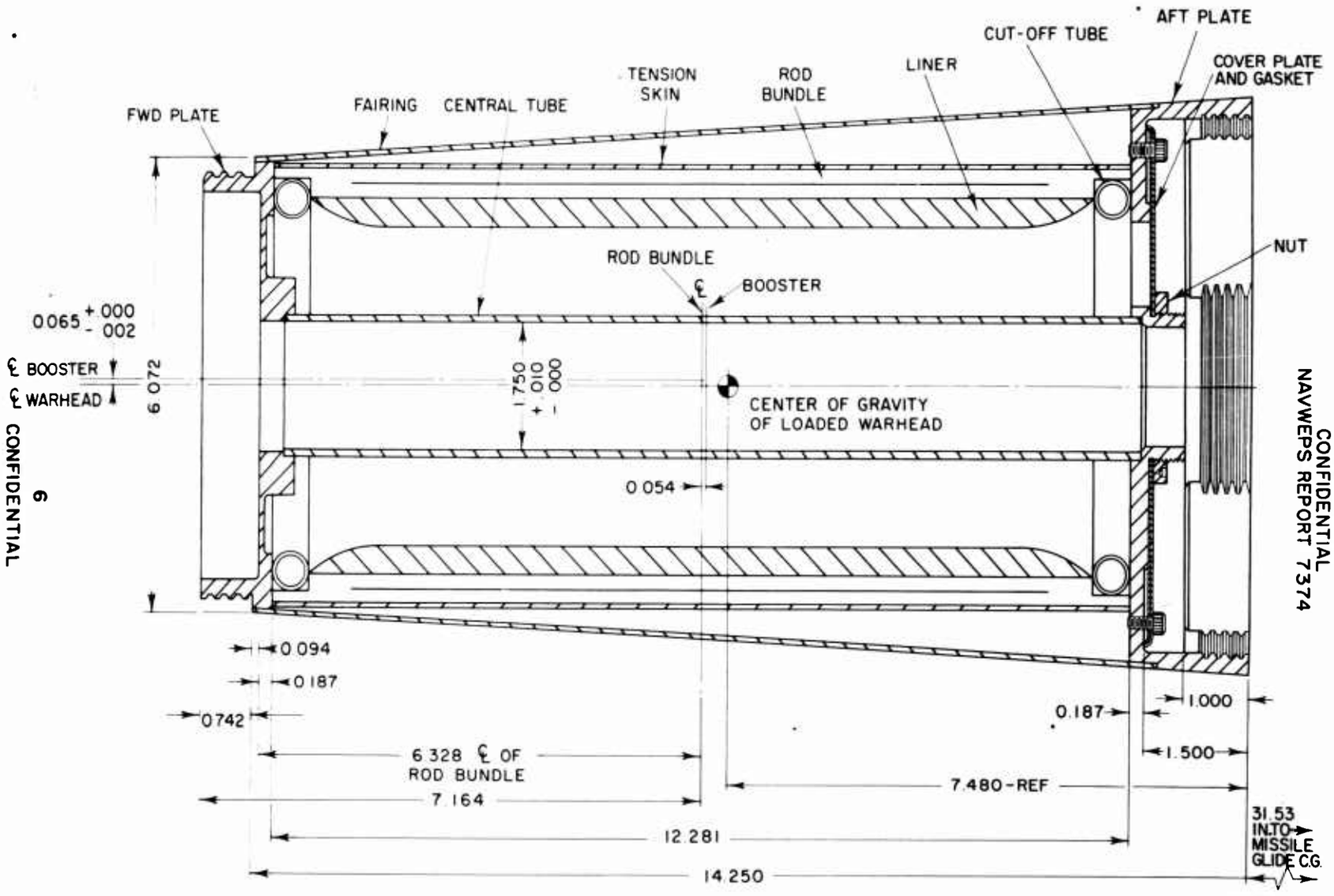

FIG. 1 GUIDED MISSILE WARHEAD EX 25 MOD 0 PRELIMINARY
BUORD DWG. 1518650

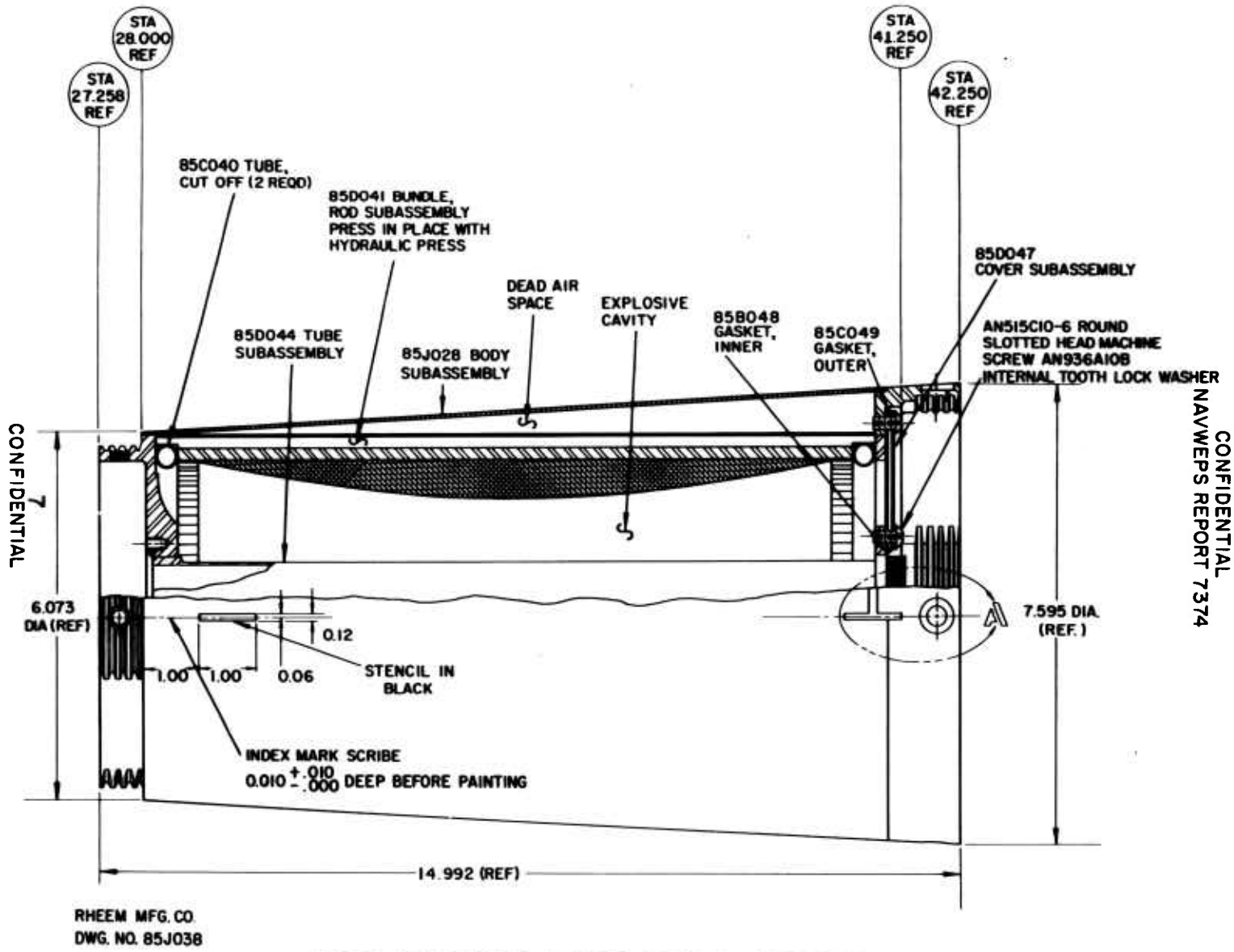

FIG. 2 WARHEAD EX 25 MOD 0 ASSEMBLY

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1. Missiles - Warheads
2. Missiles - Sparrow I
3. Warheads - EX 25 mod 0
4. Warheads, Continuous rod
I. Title
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